

# PATENT SPECIFICATION

1,110,004

## NO DRAWINGS.

The Inventors of this invention in the sense of being the devisers thereof within the meaning of Section 16 of the Patents Act 1949 are:—ERNST BAUER and WERNER AUHORN, citizens of the Federal Republic of Germany, residing, respectively, at 5 Alwin-Mittasch-Platz, Ludwigshafen/Rhein; and 2 Carl-Bosch-Ring, Frankenthal/Pfalz; Federal Republic of Germany.

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## COMPLETE SPECIFICATION.

### Improved Papers having High Mechanical Strength and Their Production.

- We, BADISCHE ANILIN- & SODA-FABRIK AKTIENGESELLSCHAFT, a German Joint Stock Company, of Ludwigshafen/Rhein, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- 10 The invention relates to improved papers having high stiffness, flat crushing strength, breaking length, bursting strength and folding endurance, and to a process for the production of these papers.
- 15 Papers of the said type are used particularly for the production of corrugated cardboard, punched cards for data-processing machines and other papers which are exposed to heavy mechanical stress.
- 20 High-quality papers of the said type are obtained inter alia from semi-chemical pulp, straw pulp or similar raw materials, whose relatively high cost is often disproportionate to the value of the end product, for example corrugated cardboard which is intended to be used only once.
- 25 Since the strength properties are moreover dependent substantially linearly on the weight per unit area of the paper, a given strength required corresponds to a minimum paper weight and less than this should not be used. It is obvious that it is an object of the industry to decrease this minimum weight of the paper.
- 30 Papers for the said purposes have also been made from raw materials which are less expensive than semi-chemical pulp but
- considerable disadvantages have to be tolerated. For example starting from waste paper, which moreover should consist of high-quality material, the freeness and consequently the investment and manufacturing costs must be considerably increased; if humic acid or pulp liquors in conjunction with aluminum sulfate be used, there is not only a relatively slight effect but difficulties also occur with dehydration of the paper pulp during sheet formation. 40
- Other suitable agents for increasing the strength properties of paper are water-soluble or water-swelling high-molecular-weight polysaccharides or their derivatives, such as starches, carboxymethylcellulose, mannogalactans and alginic acid, but retention of these agents by the paper fibers is very slight and their co-employment in paper manufacture necessitates a low machine speed owing to poor dewatering. Moreover the process water of the paper machines, in the presence of these polysaccharides, can only be clarified incompletely or by considerable further expenditure on flocculants. 50
- Furthermore, the use of fatty acid-alkylenepolyamine condensation products, together with if desired a starch or a polysaccharide gum, as sizing agents for paper is known from British Patent Specification No. 711,404. 55
- The present invention has for its object to improve the mechanical strength properties of paper by an inexpensive method which is easy to carry out industrially. 60
- We have found that paper can be ob-

[Price 4s. 6d.]

tained from a paper pulp containing water-soluble or water-swellable polysaccharides, or derivatives thereof, by adding a polyalkylenimine to the said paper pulp prior to further processing. Within the scope of the present specification, the term "polyalkylenimine" is not intended to include any condensation products, and in particular any higher fatty acid-alkylenepolyamine condensation products in the form of water-soluble amide salts.

Suitable polysaccharides for this purpose are the natural or chemically-modified polysaccharides enumerated above and among these particularly carboxymethylcellulose and starch or mixtures of these two substances. The amount of these substances required is as a rule from 0.5 to 3.5% by weight with reference to the fiber content of the pulp. The polysaccharides to be used should form clear solutions or, by reason of their swellability, colloidal solutions (gels) with water.

Particularly suitable polyalkylenimines are polyethylenimine and also polypropylenimine.

It is preferred to use polyalkylenimines whose 1% aqueous solutions have viscosities of from 2 to 20 centipoise at 20°C.

The process according to the invention may be used successfully with all kinds of paper fibers, both with high-grade qualities on account of saving in material and with lower-grade qualities in order to make these suitable for the said purpose. The process therefore has great importance for the re-utilization of low-grade waste paper.

The process is advantageously carried out by intimately mixing the fibrous paper pulp with the polysaccharide in the beater or in a mixing chest until the polysaccharide has passed into solution or has become swollen and finely dispersed. The pH value of the paper pulp should preferably be between 5.5 and 8.0.

When mixing of the polysaccharide into the fibrous paper pulp has been completed, the polyalkylenimine is added, advantageously in the form of a dilute aqueous solution. The further manufacture then takes place in the conventional way.

Papers which are very resistant to mechanical stress are obtained according to the process of the invention, having values for strength properties which are from 10 to 30% higher than in the case of equivalent papers which have been prepared without the addition of the said polysaccharides and a polyalkylenimine.

The improvements in the properties of the paper relate particularly to the tearing length, bursting strength, folding endurance and also to CMT value and flat crushing strength which are very characteristic factors for the corrugations in corrugated card-

board; for a definition and methods of measuring these factors reference may be made inter alia to "Die Prüfung von Rohpapier auf seine Eignung als Wellpappeneinlage" (Testing raw paper as to its suitability as a ply in corrugated cardboard) by Professor Dr.-Ing. Brecht and Dipl.-Ing. Berthold published in Wochenschrift für Papierfabrikation, No. 11/12, 1959.

The advantages of the process according to this invention extend not only to the product of the process but also to the process itself, because the more rapid dewatering in the formation of sheets permits an acceleration of the manufacturing operation by about 10%. Moreover the presence of the polyalkylenimine, which acts as a flocculating agent, makes possible a more rapid and more efficient purification of the process water of the paper machine.

The invention is further illustrated in the following Examples in which the percentages, unless otherwise stated, relate to the weight of paper fibers contained in the pulp and calculated as absolutely dry substance.

#### EXAMPLE 1

2% of a degraded maize starch, 0.5% of commercial carboxymethylcellulose, and subsequently 0.1% of polyethylenimine (viscosity in 1% solution at 20°C: 5 centipoises) in the form of a 0.5% aqueous solution are added in the beater to a suspension of fibrous material of 60% of waste corrugated cardboard, 25% of mixed waste paper and 15% of periodicals, the suspension having a solids content of 5.0%. This paper-fiber pulp is then introduced into the paper machine and therein processed in the conventional way into a paper having a weight per unit area of 140 g/sq.m. A paper having a CMT value of 2.2 is obtained.

A paper prepared in the same way but without the addition of polyethylenimine has a CMT value which is 25% lower and correspondingly lower values for breaking length, bursting strength and folding endurance. Moreover the solids content in the water in the wire section is about 60% higher and the maximum machine speed for equally good sheet formation is about 10% slower.

#### EXAMPLE 2

A suspension of fibrous material of 85% of waste corrugated cardboard and Kraft paper which have been ground in an edge mill and 15% of knot pulp, having a solids content of 2.0% is mixed in a mixing chest with 1.0% of mannogalactan and then with 0.08% of polyethylenimine (viscosity in 1% solution at 20°C: 3.7 centipoise) in the form of a 0.5% aqueous solution and the resultant paper pulp is processed in the conventional way into a paper having a weight per unit area of 130 g/sq.m.

The paper thus obtained has a CMT value of 2.0. This value, and consequently the values for breaking length, bursting strength and folding endurance, are about 15% higher than in the case of a paper without polyethylenimine added. Moreover the co-employment of polyethylenimine makes possible a machine speed which is about 12% higher and at the same time a decrease of 10 about 60% in the solids content of the waste water.

0.20% by weight, with reference to the fiber content of the paper pulp.

3. A process as claimed in claim 1 or 2 25 wherein potato starch, maize starch, carb-oxyethylcellulose, a mannogalactan or alginic acid is used as the polysaccharide.

4. A process according to any of claims 1 to 3 wherein the polyalkylenimine used is 30 polyethylenimine.

5. A process as claimed in any of claims 1 to 4 wherein a paper pulp prepared from waste paper is used.

6. A process as claimed in claim 1 carried out substantially as described in either of the foregoing Examples.

7. Paper when obtained by the process claimed in any of claims 1 to 6.

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